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Description

Electromagnetic switching device

The present invention relates to an electromagnetic switching device, in particular a contactor or a power circuit breaker, with a housing, a drive solenoid, a yoke, an armature and at least one contact,

- the drive solenoid, the yoke, the armature and the at least one contact being mounted in the housing,
- the drive solenoid, the yoke and the armature being inductively intercoupled, so that, when an inrush current is applied to the drive solenoid, the armature can be displaced into a pickup position,
- the displacement of the armature into the pickup position allowing the contact to be directly or indirectly actuated.

Electromagnetic switching devices of this type are generally known. In particular, any contactor and any power circuit breaker is constructed in this way.

Electromagnetic switching devices such as power circuit breakers and contactors contain magnetic drives which comprise a solenoid, a yoke and an armature. The yoke and the armature in this case consist of magnetizable material, for example iron sheets. If an inrush current is applied to the solenoid, a magnetic flux is produced in the yoke, exerts a force on the armature and picks it up. The armature is consequently displaced into a pickup position.

In the case of a contactor, the displacement of the armature has the effect that switching contacts connected to the armature are moved, and consequently main electrical contacts of the switching device are closed. Once application of the inrush current to the drive solenoid is completed, the armature

is moved back into a starting position by restoring springs and, as a result, the contacts are opened.

In the case of power circuit breakers, magnetic trips in which a current to be monitored flows through the drive solenoid are used. If this current exceeds a predetermined value (that is to say the inrush current), the armature is displaced and, as a result, the breaker latching mechanism is actuated, which in turn brings about the opening of the contact.

In the prior art, the yoke and the armature comprise laminated cores which are produced from individual iron sheets that are connected to one another - for example by rivets. The production from individual metal sheets that are insulated from one another is necessary in this case in particular for the avoidance of eddy currents and associated eddy current losses.

In the prior art, it is disadvantageous in particular that, as a result of the sheeting, only limited degrees of freedom of form are possible and that the sheets can only be connected to the housing and actuating elements by appropriate fastening elements. The solenoid also has to be connected to the housing or the yoke by a separate insulating frame. Furthermore, in the prior art, the striking together of the yoke and armature has the effect of restricting the service life of the magnetic system.

It would be desirable for the yoke and the armature to be able to have any desired three-dimensional structures, which would make it possible for the magnetic circuits to be optimally configured. It should also be possible for the yoke, the drive solenoid and the housing to be connected to one another in a simple and low-cost way, in particular without additional fastening elements. Furthermore, there should be good thermal coupling, to allow any heat loss occurring to be dissipated and so-called hot spots to be avoided. Furthermore, the service life of the magnetic system should be just as long as the mechanical service life of the switching device.

The object of the present invention is to provide an electromagnetic switching device which combines these advantages.

The way in which the object is achieved in principle is that the yoke and/or the armature contains or contain pulverulent magnetic material. This is because that achieves the effect at least that eddy currents can be reduced to virtually zero and any configurations of the yoke and armature are possible.

The yoke is cast with the drive solenoid and the housing, preferably by means of an - optionally unitary - casting compound. This is because that makes possible a simple, stable, durable and in particular low-cost connection of the yoke to the drive solenoid and/or the housing. The casting compound is in this case preferably permanently elastic.

The pulverulent magnetic material may be, for example, a sintered material. Alternatively, it is possible for the pulverulent magnetic material to be mixed with a polymer compound, for example epoxy resin.

If the pulverulent magnetic material surrounds a soft iron core, a highly permeable material and/or a permanent magnet, a specifically directed flux guidance and/or bistable switching behavior can be achieved.

If a sensor which is inductively coupled to a conductor connected to the contact by means of a coupling element containing a pulverulent magnetic material is arranged in the housing, a sensor signal representative of the actual flow of current through the conductor can be determined in a simple way. The sensor may alternatively be formed as a magnetic field sensor or as a flux-change sensor.

If the sensor and the coupling element are cast with each other, the connection of the sensor to the coupling element is particularly durable and stable.

Further advantages and details emerge from the following description of an exemplary embodiment in conjunction with the drawings, in which, in basic representation,

Figure 1 schematically shows an electromagnetic switching device,

Figures 2 to 5 show steps in producing the electromagnetic switching device from Figure 1 and

Figure 6 shows a detail of an electromagnetic switching device.

According to Figure 1, a contactor, as the example of an electromagnetic switching device, has a drive solenoid 1. The drive solenoid 1 is inductively coupled to a yoke 2 and an armature 3. If an inrush current I is applied to the the drive solenoid 1, the armature 3 is displaced into a pickup position, as indicated in Figure 1 by an arrow A. One result of this is that the contact 4 is actuated, to be precise is closed. Therefore, an electrical connection is established between conductors 5 connected to the contact 4.

The drive solenoid 1, the yoke 2, the armature 3 and the contact 4 as well as the conductors 5 are mounted in a lower housing part 6. The lower housing part 6 is detachably connected to an upper housing part 7 by means of fastening elements 8, which are only schematically represented in Figure 1. The lower housing part 6 and the upper housing part 7 together form a housing 6+7 of the electromagnetic switching device.

The construction described above for a contactor also applies in principle to the switching device formed as a power circuit breaker. The only difference is that, in the case of a power circuit breaker, the drive solenoid 1 is flowed through by a

current to be monitored and the displacement of the armature 3 does not have the effect that a contact 4 is directly closed, but opened indirectly by actuation of a breaker latching mechanism. In this case, the electrical connection between the conductors 5 is therefore interrupted by the displacement of the armature 3.

The construction of the electromagnetic switching device from Figure 1 is now explained in more detail below in conjunction with the sequence of Figures 2 to 5.

Firstly, the yoke 2 is produced in advance - see Figure 2. It consists of pulverulent magnetic material 9 or contains such material 9. The pulverulent magnetic material 9 may be, for example, sintered material. The pulverulent magnetic material 9 may, however, also be a metallic powder which is mixed with a polymer compound, for example epoxy resin. As represented in Figure 2, the yoke 2 may contain further elements 10, 11. For example, the yoke 2 may contain a permanent magnet 10. In this way it is possible, for example, to achieve a bistable switching behavior of the switching device. However, the yoke 2 may also contain a soft iron core 11 or some other highly permeable material. In this case, a specifically directed flux guidance of the magnetic field in the yoke 2 is obtained. The elements 10, 11 are surrounded at least on two sides, preferably at least on four sides, possibly even on all sides, by the pulverulent magnetic material 9.

After producing the yoke 2, the drive solenoid 1 is loosely applied to the yoke - see Figure 3. The drive solenoid 1 and the yoke 2 are then cast with each other - see Figure 4 - by means of a permanently elastic casting compound 12. The block of casting compound 12 is finally cast - see Figure 5 - with a hard casting material 13. The hard casting material 13 thereby forms at least part of the lower housing part 6.

The casting with the hard casting material 13 has the effect of producing at the same time an intimate bond between the lower housing part 6, the yoke 2 and the drive solenoid 1 by means of the permanently elastic casting compound 12. The drive solenoid 1, the yoke 2 and the lower housing part 6 are consequently cast with one another in a unitary manner by means of the casting compound 12.

As can be seen from Figure 5, the fastening elements 8 for connecting the lower housing part 6 to the upper housing part 7 are arranged on the lower housing part 6 in the casting material 13. Further fastening elements 14 are arranged in the casting material 13. By means of these fastening elements 14, the lower housing part 6 can be connected to a fastening surface 15, which is only schematically indicated in Figure 5.

The production of the yoke 2 using the pulverulent magnetic material 9 and the lower housing part 6 of the hard casting material 13 has been described above. However, the above statements concerning the yoke 2 and the lower housing part 6 can be applied in an entirely analogous way to the production of the armature 3 and the upper housing part 7.

Figure 6 then shows an extension of the switching device of Figures 1 to 5. According to Figure 6, a sensor 16 is arranged in housing 6+7. The sensor 16 is inductively coupled to one of the conductors 5 by means of a coupling element 17. By analogy with the yoke 2 and the armature 3, the coupling element 17 contains pulverulent magnetic material 9 or preferably even consists of such material. By means of the sensor 16, consequently a sensor signal that is representative of the current flow through the conductor 5 can be directly sensed.

As indicated in Figure 6, the sensor 15 may be formed for example as a solenoid 16. In this case, the sensor 16 is a flux-change sensor. It can therefore only be used in the case

of alternating voltages or for detecting a switching operation. The sensor 16 may, however, also be formed as a magnetic field sensor, for example as a Hall sensor. In this case,

the magnetic field as such, and consequently the current flow in the conductor 5, can be sensed by means of the sensor 16.

By analogy with the casting of the yoke 2 with the drive solenoid 1, the sensor 16 is preferably also cast with the coupling element 17, as schematically indicated in Figure 6.

Consequently, entirely novel structures for the yoke 2 and the armature 3, even for the entire electromagnetic switching device, can be realized in a simple way by means of the switching device according to the invention.